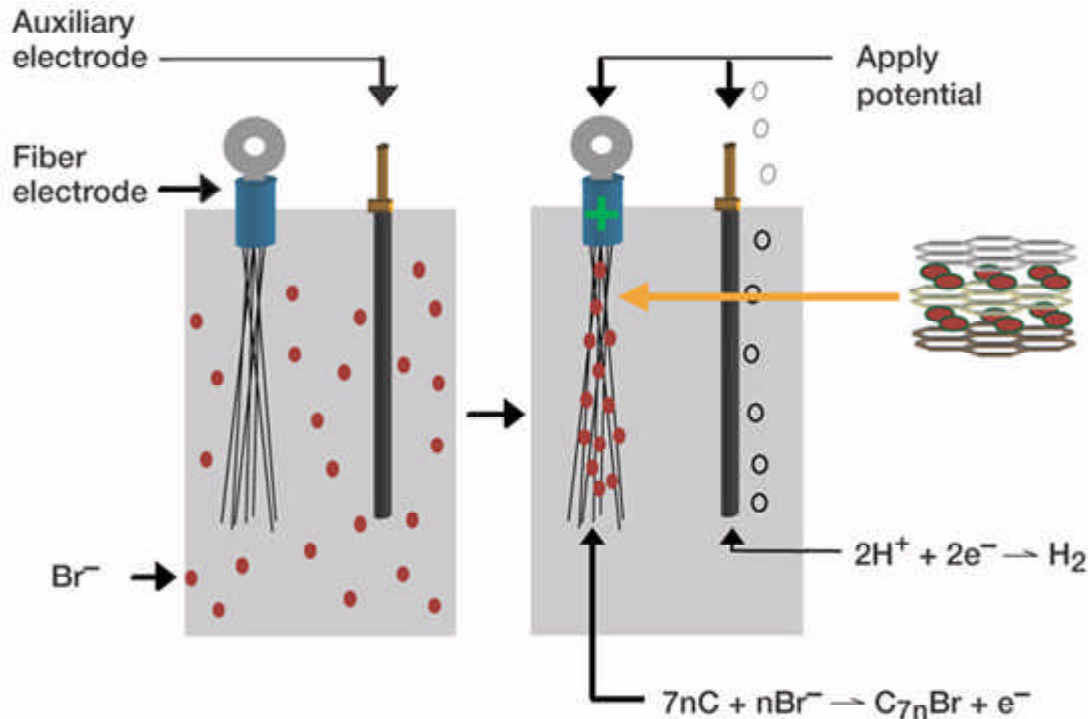


Greener Method Developed for Intercalating Graphite Fibers With Bromine



Method used to carry out the electrochemical intercalation of graphite fibers using Br^- .

Long description. The electrochemical cell pictured on the left identifies the fiber electrode, the auxiliary electrode, and the bromide ions in solution. To the right, the same cell is shown with the effects of applying a potential. The bromide ions are being intercalated into the fiber electrode, and hydrogen gas is being generated at the auxiliary electrode. The chemical equations for the half reactions occurring at each electrode are also shown: $7n\text{C} + n\text{Br}^- \rightarrow \text{C}_{7n}\text{Br} + e^-$ at the bottom of the fiber electrode and $2\text{H}^+ + 2e^- \rightarrow \text{H}_2$ at the bottom of the auxiliary electrode.

The electrical resistivity of graphite fibers can be lowered by as much as a factor of 10 by the process of intercalation: the insertion of guest atoms or molecules between the graphene planes. Composites fabricated from such resistivity-enhanced fibers are excellent candidates for the replacement of metallic components such as electromagnetic interference shields and grounding planes (ref. 1). The most promising intercalate for such applications is bromine because of the stability of the intercalation compounds in air, vacuum, humidity, and high temperature.

These fibers have been fabricated primarily by exposing pitch-based or vapor-grown

graphite fibers to bromine vapor. Bromine vapors are caustic and toxic. In addition, bromine gas has been implicated in the depletion of the Earth's protective ozone layer. If a synthesis route could be developed that used the relatively innocuous bromide ion (Br^-), the synthesis could be made less dangerous, and the possible effect on the ozone layer could be reduced.

Electrochemical methods have used Br^- to form bromine-intercalation compounds with graphite fibers and foils. However, the resulting compounds did not have resistivity values as low as those formed using the vapor diffusion method. Researchers working in the Electro-Physics Branch of the NASA Glenn Research Center have found that, if the temperature is lowered to near the freezing point and the electrochemical current is kept very high, the same low-resistivity intercalation compound is formed as by the vapor diffusion method. The intercalation mechanism is thought to involve the formation of Br_2 at the surface of the fiber, which then intercalates the graphite by the same mechanism as the vapor diffusion method. Glenn's researchers also found that, in keeping with this mechanism, highly crystalline graphite can be intercalated by an aqueous Br_2 without the benefit of electrochemical current. This technique could greatly simplify and make much safer the industrial-scale synthesis of bromine-intercalated graphite fibers.

References

1. Gaier, J.R.: Intercalated Graphite Fiber Composites as EMI Shields in Aerospace Structures. IEEE Trans. Electromagn. Compat., vol. 34, issue 3, pt. 1, 1992, pp. 351-356.

Glenn contact: Dr. James R. Gaier, 260-982-5075 (Feb-May, Sept-Dec), 216-433-6686 (Jan, Jun-Aug), James.R.Gaier@nasa.gov

Author: Dr. James R. Gaier

Headquarters program office: OAT

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